Oct. 20, 1964 L. WHITEHEAD 3,153,783

STACKED HORN ARRANGEMENT

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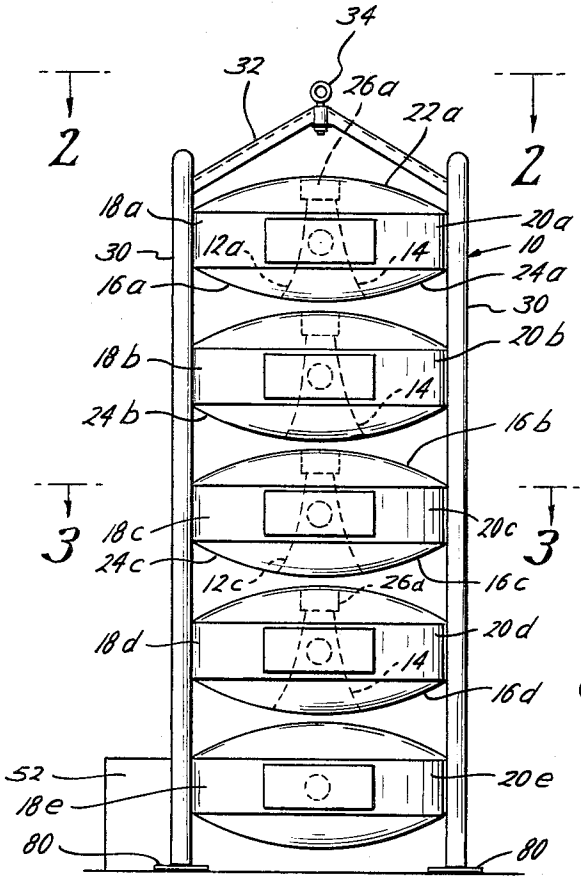
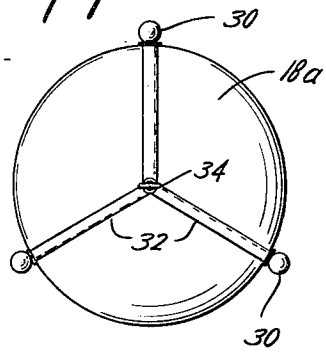


Fig. 1

Fig. 2



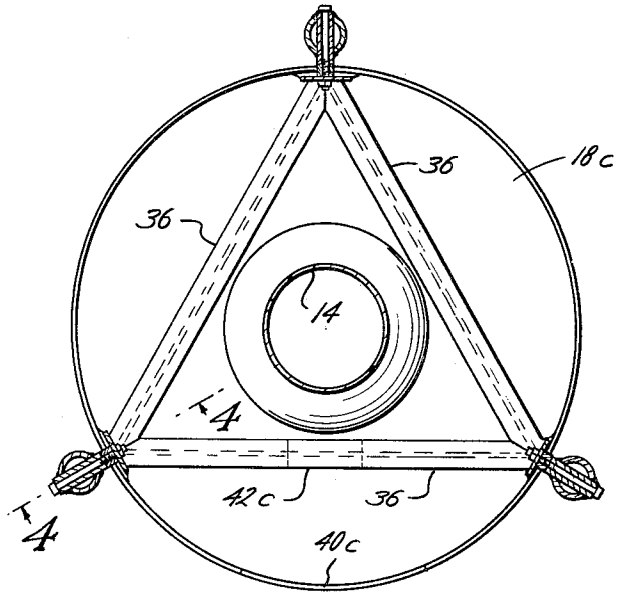


Fig. 3

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Fig. 4

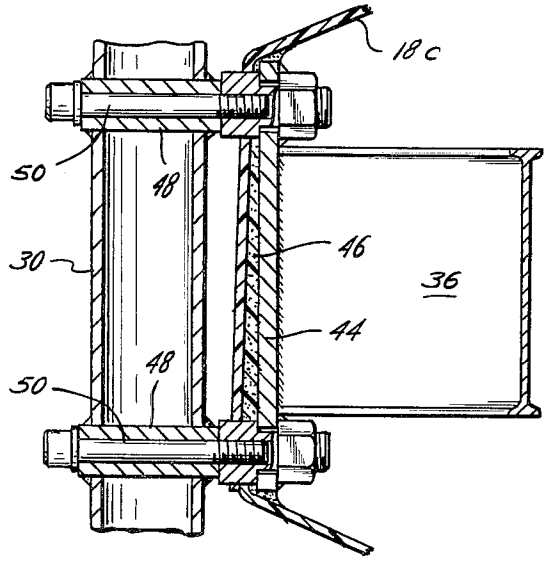


Fig. 5

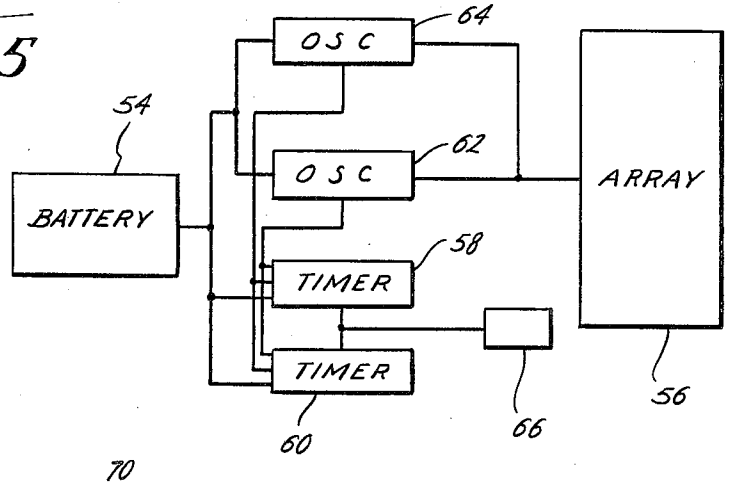
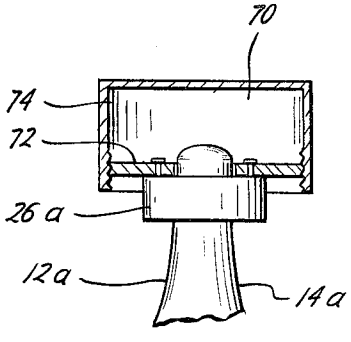


Fig. 6



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STACKED HORN ARRANGEMENT

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The present invention relates to a horn, and more particularly, relates to a horn which will project sound omnidirectionally, in a horizontal plane, over large distances. This application is a continuation-in-part of my copending application entitled Fog Horn, filed April 1, 1963, Serial No. 269,467, now abandoned.

It is a general object of the present invention to provide a horn which includes a plurality of vertically stacked hyperbolic horns which are folded in such a manner to produce a signal directed in all horizontal directions.

It is still a further object of the present invention to provide a horn which can be used as a fog horn and provides an electronic fog signal which utilizes no moving parts and which produces a dependable signal for the required two mile range as specified by the Code of Federal Regulations.

A still further object of the present invention is the provision of a horn which is composed of weather proof components and is structurally supported to withstand forces of up to 200 knots.

A still further object of the present invention is the provision of a horn which has dual timer and oscillator circuits for maximum reliability with the timer circuits synchronized and which can be used as a fog horn for offshore use which gives a continuous and unattended operation.

Yet a further object of the present invention is the provision of a horn which includes a plurality of vertically stacked drums or horn envelopes which are shaped to form a plurality of vertically stacked hyperbolic developed horns, each of the drums or envelopes including a downwardly directed vertical portion of the horn and the bottom of one envelope or drum and the top of the next adjacent lower envelope or drum forming the horizontally directed portion of the hyperbolic horn which is in communication with the vertical portion and thus provides a horn which is directed in a horizontal plane in all directions and which provides a sound output over an extremely large area.

A still further object of the present invention is the provision of a horn which has a plurality of vertically stacked horns which utilizes a minimum of external vertically extending braces and includes horizontally extending braces interiorally of the horns and connected through the horns to the vertically extending braces.

Yet a still further object of the present invention is the provision of a horn having a threadably attached tuning chamber connected to each of the horn drivers for simply and easily tuning all of the drivers to the same frequency.

A still further object of the present invention is the provision of greater than a one-half wave length spacing of the horns for providing a greater horizontal factor of sound output.

A still further object of the present invention is the provision of a plurality of vertically stacked horns, the horns being hyperbolic in development and the throat of each horn is positioned at the top of the horn and having a downwardly directed vertical portion and having an annular horizontal portion connected to the vertical portion with the mouth of the horn being directed horizontally in a 360° direction. In addition, the present invention provides a horn having a greatly increased range over present horns and thereby has been found to be particularly useful in loud speaker systems and on a fog horn.

Other and further objects, features and advantages will be apparent from the following description of a presently preferred embodiment of the invention, given for the purpose of disclosure, and taken in conjunction with the accompanying drawings, where like character references designate like parts throughout the several views, and where,

FIGURE 1 is an elevational view illustrating a horn constructed according to the present invention,

FIGURE 2 is a cross section taken along the line 2—2 of FIGURE 1,

FIGURE 3 is an enlarged cross sectional view taken along the line 3—3 of FIGURE 1,

FIGURE 4 is an enlarged cross sectional view taken along the line 4—4 of FIGURE 3 showing the details of construction of the horn drums or horn envelopes to the structural support,

FIGURE 5 is an electrical block diagram illustrating an electrical system that is useful when the present invention is used as a fog horn, and

FIGURE 6 is a fragmentary elevational view, partly in cross section, showing the adjustable tuning chamber which is on the back of each of the horn drivers.

Referring now to the drawings, and particularly to FIGURE 1, the numeral 10 generally designates the horn of the present invention. The horn 10 is useful for many purposes where an omnidirectional signal, in a horizontal plane, over a large area is desired, and where vertically directed output is not required. By way of example only the horn 10 is useful for a loud speaker system and also is ideal for use as a fog horn which will meet the requirements of the U.S. Coast Guard for a two mile signal as well as provide a unit which will be usable on offshore structures to withstand forces up to 200 knots.

A plurality of vertically stacked hyperbolic horns 12*a*, 12*b*, 12*c* and 12*d* are provided which include a vertical portions 14*a*, 14*b*, 14*c*, 14*d* respectively and an annular horizontal portion 16*a*, 16*b*, 16*c*, and 16*d*, respectively, which is in communication with the vertical portion and provides a directed sound in all horizontal directions. Of course, any number of horns may be used depending upon their desired output and, by way of example only, the present invention will be described with reference to a four horn unit shown in FIGURE 1.

The vertical stack of identical hyperbolic horns 12*a*, 12*b*, 12*c*, and 12*d* are formed by a plurality of vertically spaced circular horn drums or horn envelopes 18*a*, 18*b*, 18*c*, 18*d* and 18*e*, respectively. While the drums 18*a*, 18*b*, 18*c*, 18*d* and 18*e* include a cylindrical portion 20*a*, 20*b*, 20*c*, 20*d* and 20*e*, respectively, for structural attachment to a suitable bracing structure, which will be more fully described hereinafter, it is particularly noted that the tops 22*a*, 22*b*, 22*c*, 22*d*, 22*e*, and the bottoms 24*a*, 24*b*, 24*c*, 24*d*, and 24*e* are curved in a hyperbolic function. These curved tops and bottoms form the annular horizontal horn section portions 16*a*, 16*b*, 16*c*, 16*d*, respectively of the hyperbolic horns 12*a*, 12*b*, 12*c* and 12*d*, respectively. In addition, the horns or envelopes include the vertically directed openings forming the vertical portions 14*a*, 14*b*, 14*c*, and 14*d* which are in communication with the horizontal horn portions and are also formed in a hyperbolic shape. That is, each respective communicating vertical and horizontal horn portions 14 and 16 form a single hyperbolic shaped horn 12 having a downwardly directed vertical portion 14 and an annularly directed horizontal output portion 16.

It is to be particularly noted that the drum or horn envelopes with the exception of 18*a* and 18*e*, which only provide a single horn surface, but which are constructed as the other drums or envelopes for ease of manufacture, form the lower structure for the next adjacent upper horizontal horn portions 16 by the top surfaces 22*b*,

22*c*, 22*d* and 22*e* and provide the upper horizontal surface for the horizontal portions 16*a*, 16*b*, 16*c*, and 16*d*, respectively of the horns with their lower surfaces 24*a*, 24*b*, 24*c*, and 24*d* respectively. Therefore, the number of desired individual horns 12 may be provided by merely increasing the vertical stack of drums or envelopes 18. In addition, it is particularly noted that because of the shape of the drums 18*a*, 18*b*, 18*c*, 18*d* and 18*e*, they present from all angles a curved surface to a wind force and thus are able to be supported on a structure which can be provided to withstand wind forces up to 200 knots.

A driver 26*a*, 26*b*, 26*c* and 26*d* is provided in each of the drums 18*a*, 18*b*, 18*c* and 18*d*, respectively at the throat of the upper end of the vertical portions of the horns 12*a*, 12*b*, 12*c*, and 12*d*, respectively. Thus it is noted that with proper sealing and because of the fact that the vertical portions 14 of the horns are directed downwardly the only weather sensitive portion of the horns, the drivers, are fully protected from the rain and other weather conditions.

It is noted that the output of all of the vertically stacked horns will be in a horizontal plane and directed to provide an omnidirectionally horizontal signal. In addition, it is preferable that the spacing of the horns be at a distance of .85 the wave length, when a fixed frequency signal is used, which gives a horizontal directivity or horizontal output greater than the mere total of the number of horns. Thus, the output of the apparatus 10 in FIGURE 1, instead of being merely the total output of the four horns, would because of the .85 wave length spacing produce a horizontally directed output of approximately six times the output of a single horn.

Referring now particularly to FIGURES 1–4, the structural supports and bracing of the present apparatus 10 is best seen. A plurality of upright members 30, preferably 3 inch round pipes which offer little resistance to wind forces, are provided for supporting the vertically stacked drums or envelopes 18*a*, 18*b*, 18*c*, 18*d* and 18*e*. In addition a suitable supporting bracing 32 having an eye hook 34 may be provided connected to the top of the supports 30 for ease of handling the apparatus 10. Bracing internally of the drums or envelopes 18*a*, 18*b*, 18*c*, 18*d* and 18*e* is provided, which may be in the form of I beams 36 which are connected to each other and at their ends to the upright supports 30. It is noted that the cross bracing 36 since it is positioned internally of the drums or envelopes will not be subjected to any wind forces. As best seen in FIGURES 1 and 3, doorways 40*a*, 40*b*, 40*c*, 40*d*, and 40*e* are provided in the horns or envelopes 18*a*, 18*b*, 18*c*, 18*d*, and 18*e* respectively to provide an entrance into the interior of the horns or envelopes. In addition, as best seen in FIGURE 3 an opening 42 is provided in the I beam bracing support 36 adjacent the doorways 40 in order to provide suitable access from the outside to allow maintenance work to be conducted on each of the drivers 26.

Referring to FIGURE 4 it is noted that the cross brace I beams 36 terminate and are welded to a plate 44. Preferably, the drums or envelopes are made of fiberglass and a fiberglass fill 46 is provided between the plates 44 and the drums 18 to bond the plates and drums together for support and sturdiness. A suitable pair of sleeves 48 are provided through the upright supports 30 to each of the plates 44 in which a suitable nut and bolt assembly 50 is provided to secure the plates 44 and thus the drums to the vertical upright supports 30.

As best seen in FIGURE 1, a suitable cabinet or box 52 may be provided to hold the necessary electrical controls or circuits which may include batteries for operation of the apparatus 10. Preferably, as best seen in FIGURE 5 a redundant or dual circuit is provided, when the horn 10 is used in a remote location such as a fog horn, for maximum reliability so that it may be located in unattended areas. That is, a suitable electric source, such as battery 54, may be provided which is connected to dual timer and oscillator circuits for actuating the array 56, that is, all of the drivers 26*a*, 26*b*, 26*c* and 26*d*. That is, dual timers 58 and 60 are provided for actuating dual oscillator circuits 62 and 64. Thus, in the event that any of the oscillators and/or any one of the timers fail, the horns will continue to operate. However, a synchronous cross coupling circuit 66 is connected between the timers 58 and 60 to insure that they are in synchronism, or otherwise they will be operated individually and produce a non-uniform output sound.

For some uses, it is desirable that the output of all the drivers 26*a*, 26*b*, 26*c* and 26*d* be tuned to the same frequency. Therefore, referring to FIGURE 6, a tuning chamber 70 is provided on the back of the drivers which can be quickly and easily adjusted to tune each of the drivers. A plate 72 is secured to each of the drivers 26. Threadably connected to the plate 72 is a cylindrical box thereby forming the tuning chamber 70 with the plate 72. The cylindrical box 74 may be threadably screwed toward or away from the plate 72 thereby varying the volume of the tuning chamber 70 and thus tuning the output from the driver 26.

In use, the assembled apparatus 10 is conveniently connected at a desired location by the foot plates 80 and will provide a fog horn having the required two mile signal which may be timed by an electrical circuit to provide a suitable periodic signal such as a two second horn signal followed by 18 seconds of silence. With a suitable battery capacity, the apparatus 10 will have a life to produce the proper fog horn signal for almost one year and thus can be utilized in unmanned locations such as offshore structures. The vertically stacked horns 12*a*, 12*b*, 12*c* and 12*d* because of their construction will provide a signal which is directed in a horizontal plane in all directions. The signals will combine with each other and because of the .85 wave length spacing of the horns, will provide a greater output than the sum of the individually stacked horns. Because of the shape of the drums or horn envelopes 18*a*, 18*b*, 18*c*, 18*d* and 18*e* the present invention may be quickly and easily manufactured, and any desired member of horns may be quickly and easily assembled, and when assembled will provide a structure which will not only produce the required signal output but will withstand wind forces up to 200 knots. In addition, the doors 42 on the horns or envelopes may be quickly and easily opened to allow any maintenance work on the drivers 26 which may be required, and all of the drivers may be suitably tuned in the field by means of the adjustable tuning chamber 70. Because of the use of hyperbolic horns, stacked in the manner shown, a required two mile, 400 cycle signal can be provided. And because of the redundant control circuit, the present apparatus may be installed in remote and unmanned areas, and still perform with maximum dependability and reliability.

In addition, the horn 10 may be conveniently used for voice or other loud speaker systems and will have the advantage of serving greater areas than conventional comparably powered units. For instance it can be used for civil defense warning and instructions, public address system in halls and stadiums. However, it may be desirable to mount the horn 10 on towers or on suspension cables at 25 foot heights when so used. Conventional amplifiers and electrical circuits are utilized when used as a public address system.

The present invention, therefore, is well adapted to carry out the objects and attain the ends and advantages mentioned as well as others inherent therein. While a presently preferred embodiment of the invention is given for the purpose of disclosure, numerous changes in details of construction and arrangement of parts may be made which will readily suggest themselves to those skilled in the art and which are encompassed within the spirit of the invention and the scope of the appended claims.

What is claimed is:

1. A vertically stacked hyperbolic horn comprising,

a plurality of circular drums vertically stacked, each of said drums including a vertical opening forming a downwardly directed vertical portion of a hyperbolic developed horn,

a driver positioned on each of the circular drums at the top of the vertical portion of said horn and directed downwardly,

the bottom of each drum and the top of the next adjacent lower drum being shaped to form an annular horizontally directed hyperbolic portion of said horn which is in communication with the vertical portion of said horn next above thereby providing an annular horn mouth being horizontally directed in a 360° direction, and

the mouth of said horns being vertically spaced from each other at approximately a distance of .85 wave lengths.

2. The invention of claim 1 including a control circuit for operating all of said horns comprising,

a battery,

dual timer and oscillator circuits connected in parallel to said battery and said horns, and

a timer synchronization circuit connected between said timers.

3. The invention of claim 1 including,

a plurality of vertically extending tubular supports connected to and supporting said drums, and

horizontally extending bracing interiorly of said drums and connected to said vertically extending supports.

4. The invention of claim 1 including,

a tuning chamber, said chamber threadably connected to the back of each of said drivers whereby the volume of the tuning chamber can be varied for tuning the drivers.

5. A vertically stacked hyperbolic horn comprising,

a plurality of circular fiberglass drums, each of said drums including a vertical opening therethrough, said opening being shaped to form a downwardly directed vertical portion of a hyperbolic developed horn, but said drums being otherwise closed and thereby being floatable,

a driver positioned on each of the circular drums at the top of the vertical opening and directed downwardly,

the bottom of each drum and the top of the next adjacent lower drum being shaped to form an annular horizontally directed hyperbolic portion of said horn which is in communication with the vertical portion of said horn next above thereby providing an annular horn mouth being directed horizontally in a 360° direction, and

the mouth of said horns being vertically spaced from each other at approximately a distance of .85 wave lengths.

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